SPAWNING OF CARP AND THEIR SPAWNING GROUNDS IN THE PUNJAB.

BY

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(*With* 5 *text-figures*).

In India, the Carp (*Cyprinidae*) are the most valuable of the fresh water fishes, the species most prized being the Rohu, [*Labeo rohita* (Hamilton)], Mirgal, Morakha or Mori [*Cirrhina mrigala* (Hamilton)], and Theila or Katla [*Catla catla* (Hamilton)]. These fish, though they grow rapidly in tanks and ponds, do not seem to breed in confined waters (Gupta, 1908), and are said 'to breed only in the running water of the river', (Bull. 2 Dept. Fish. Bengal, 1913). Day (1873, p. 26), however, mentions that 'in those tanks, which are always in communication with irrigation works or large rivers, many species of non-migratory fish breed, and also a few of the migratory ones'. Thomas (1897, p. 341), also describes his experiment at Vallaum in the Tanjore District, where *Labeo* fry were introduced in 'a rain-fed pond of some three to five acres of waterspread', and remarks that, 'the natives were very positive that they never breed in ponds, but needed running water. I thought they might be induced to try breeding in a pond when they found it impossible to get to a river, and the event proved I was right. After a time, Labeo fry were caught very much smaller and more numerous than I had put in.' Dunsford (1911), too, narrates an incident at Hissar, where after the first heavy fall of rain at the commencement of the monsoon, large fish, namely, rohu, were seen rushing about over inundated ground and were either 'females full of ripe spawn or males full of milt'. In 1924, the author (Hamid Khan, 1924), observed that the Indian Carp could be made to spawn in tanks and ponds provided that all the conditions of their natural spawning grounds were taken into consideration, and that in the absence of proper facilities the fish become egg bound and the eggs degenerate in the ovaries. Recently, Majumdar (1940) has pointed out that 'the statement that the European carps breed in confined waters, while the bigger types of Bengal do not is not exactly correct. It has been observed that they also breed well in confined or semi-confined waters during the monsoon in this country.' He, however, admits that owing to unfavourable circumstances the carps in confined waters 'reabsorb their eggs in their system.'

The spawning behaviour of the Indian Carp is really very peculiar and requires thorough investigation. Observations on their spawning have been recorded by the Fisheries Staff from various stretches of water in the Punjab during the last 18 years and their spawning grounds have also been surveyed. As a result of these observations, an attempt has been made in this paper to discuss, *firstly*, the probable factors which induce the Carp to spawn under natural con-

ditions, and *secondly,* the possibility or otherwise of the spawning of Carp in confined or semi-confined waters.

A. Spawning of Carp in Rivers and their Tributaries.

1. *River Beas.*—Observations on the spawning of Carp were recorded from River Beas and its tributaries, namely *Barnai Cho, Gural Nala, Karabara,* and *Western Bein.*

(i) *Barnai Cho, Gural* and *Karabara* streams (Fig. 1). In 1922, River Beas, which is one mile from *Barnai Cho* near the village *Mehtabpur,* where an observation camp was established, was in flood on the 15th July, and the next day, due to heavy local rains the river overflowed and flooded *Barnai Cho* as well. The same evening, the fish, weighing 4 to 8 lbs. each, approximately, from the river and *Barnai Cho* were observed rushing about over the inundated fields, where water was 9 to 12 inches in depth, were playing together and laying their eggs. The water in many places was hardly sufficient to cover their backs and the fish could easily be killed in any number with a *lathi* blow. Immediately after spawning the eggs were collected. The eggs were demersal and were lying on the submerged grass or in shallow pits in heaps, but were not sticking to each other. Each egg measures 1.5 to 2 mm. in diameter, but as soon as it falls into the water it swells to 2 to 3 times its size by the absorption of water by its outer membrane, which gives it a glassy bead like appearance (Hamid Khan, 1924). This watery sheath acts as a protective covering to the developing embryo. The eggs do not float, but are often carried by the strong current of the flood into the main stream where they can be collected by means of fine meshed nets as is done in Bengal.

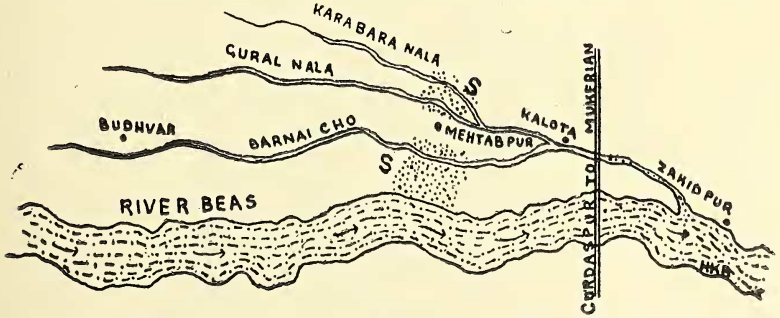

Fig. 1.—Diagrammatic sketch of spawning grounds (*S*) of the River Beas and its tributaries.

The temperature of water in the spawning grounds was 85°F. at 8 a.m., 81°F. at 4 p.m. and 82°F. at 7-30 p.m. The fish netted from the spawning grounds were *Labeo rohita* (Hamilton), *Labeo micropthalmus* Day, *Labeo gonius* (Hamilton) and *Barbus sarana* (Hamilton). Some of these fish were full of eggs and others were spent up. The latter were seen returning to the main stream.

Gural stream is hardly two furlongs from *Barnai Cho* near the village Mehtabpur, but this stream was not flooded with floods from the river on the 16th July. Consequently its fish did not spawn

on that day. It, however, rained heavily on the 29th July and Gural was flooded on the morning of the 30th, and *Karabara* on the same evening. Both the streams overflowed into the surrounding fields. On the 31st morning the fish were observed playing and spawning in the inundated fields where water was 4 to 5 inches in depth.

The temperature of the water of the stream on the 30th July was 78°F. at noon and the water in the spawning ground had a temperature of 80°F. on the 31st morning.

In 1934, *Barnai Cho* overflowed its banks due to rains in the up country on the 8th July and its fish spawned on that day. But the river Beas got flooded on the 16th July and overflowed into the fields and its fish spawned on the night between the 16th and the 17th July. *Gural* had its flood on the 26th July and inundated the fields at 11 a.m. and at 2 p.m. its fish were seen playing and splashing in the fields. The temperature of the water in the spawning grounds remained 87°F. throughout the day. A partly spent up female of *Labeo gonius* was netted from the spawning grounds, stripped and its eggs fertilized successfully. They hatched out on the 27th July, *i.e.,* sixteen to seventeen hours after stripping.

(ii) *Western Bein.* Owing to rains in up country, the *Bein* stream was flooded on the 21st July in 1922. On the same evening it overflowed into adjoining fields near village *Dhirpur*, at a distance of three miles from village *Manan Talwandi* where an observation camp had been established. The fish from the *Bein* responded to the floods, moved on to the flooded fields along the current of water, rubbed themselves against the furrows of ploughed up fields, where depth of water was 2 to 18 inches, and made a noise like *boon boon.* The male closely followed the female, rubbed against its mate and both of them raised their caudal portions just above the water with their bodies pressed together. They remained in this position for 2 to 3 seconds, and it was thus that the female ejected its eggs which were immediately fertilized by the male. Due to muddy water the actual ejection of the eggs could not be seen, but it was noticed that in the females of *Labeo gonius* netted from the spawning grounds, when pairing, the eggs simply flowed out with slight pressure and were fertilized with the milt which a male yielded readily. Immediately the pair separated, they made great splashing noise. No fish stayed long at one place but wandered about with its mates. The eggs could be felt, by hand, lying at the bottom on the grass and were crushed when one walked in the water. When water was stirred the eggs came to the surface and were collected. Development started immediately after fertilization.

The temperature of the water of the *Bein* ranged from 84°F. in the morning to 94°F. in the afternoon. On the spawning grounds the temperature of the water on the 21st July at 11 p.m. was 85°F. and on the 22nd July it was 80°F. at 3 a.m.

2. *River Sutlej* (Fig. 2). Observations on the spawning of Carp in *Budha Nala*, a tributary of River Sutlej were carried out in 1929, 1931 and 1935.

In 1929, it rained heavily on the 18th July and flooded the *Budha Nala*, which overflowed into the surrounding fields, where fish were seen playing on the same day. One ripe female, *Barbus*

sarana, netted from the inundated fields, yielded its eggs readily and these were successfully fertilized by mixing milt from the male.

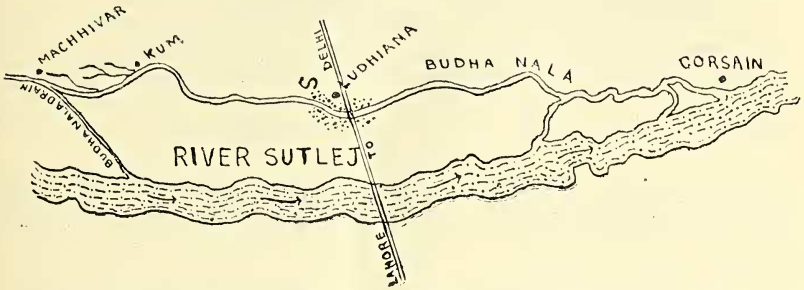

Fig. 2.—Diagrammatic sketch of spawning grounds, (*S*), of Budha Nala, a tributary of River Sutlej.

In 1931, the spawning in the *Budha Nala* was observed on the 22nd July, when the stream was flooded not with the local rains but with the rain at its upper reaches. In 1935, it rained on the 14th July, but the stream was not sufficiently flooded and the fish did not spawn. On the 18th July, there was another heavy shower, the stream overflowed and the fish spawned in the inundated fields.

Recently, the Irrigation Department, with a view to reclaim land from water-logged areas, have converted the upper reaches of the *Budha Nala* into a drain, thus preventing the stream from overflowing its banks during the rains. The fish, consequently, have been deprived of their natural spawning grounds.

3. *River Ravi.*—(i) *Jabboki spawning grounds*: With floods in River Ravi during monsoon, the fish of almost all kinds ascend to the inundated fields near village *Jabboki*, about 7 miles from Lahore, play together, lay their eggs and return to the river. When the floods subside, pools are left in the spawning grounds where numerous fry get stranded.

(ii) *Kiran Nala* (Fig. 3), known as *Doga* in its upper reaches and *Sakki* in its lower, is a tributary of River Ravi and joins it

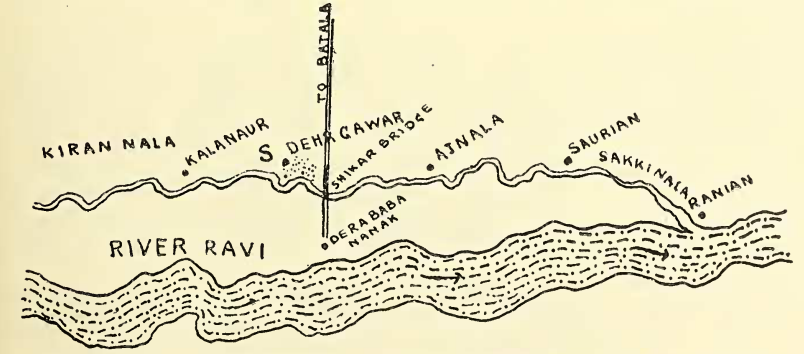

Fig. 3.—Diagrammatic sketch of spawning grounds, (*S*), of *Kiran Nala,* a tributary of River Ravi.

near village *Ranian.* Spawning grounds of fish extend all along the stream. Observations on the spawning of Carp were recorded

from one near *Dehr gawar* (Fig. 3. *S*). The stream, during monsoon, overflows into the fields near this village, where fish spawn and after laying their eggs return to the main stream.

Construction of a weir near Shikar Bridge on the *Kiran Nala*, for storage of water in its upper reaches for lift irrigation, has, of recent years, obstructed the passage of fish to their spawning grounds. It is a matter of regret that no facilities have been provided to enable the fish to reach their natural spawning grounds.

B. Spawning of Carp in Tanks which are connected with streams, rivers or with any other piece of Running Water during the Monsoon.

Such tanks and ponds are of two distinct forms, *firstly* those which always or nearly always contain water throughout the year, as for instance tanks at *Chhenawan* Fish Farm, and *secondly,* those which get dry during early summer and get inundated during the rains, as for example ponds at *Khori.*

(i) *Chhenawan Tanks,* (Fig. 4). Near village *Chhenawan* there is an old supply channel, extending to a distance of six miles upto the River Chenab, where a fish culture station, first recommended

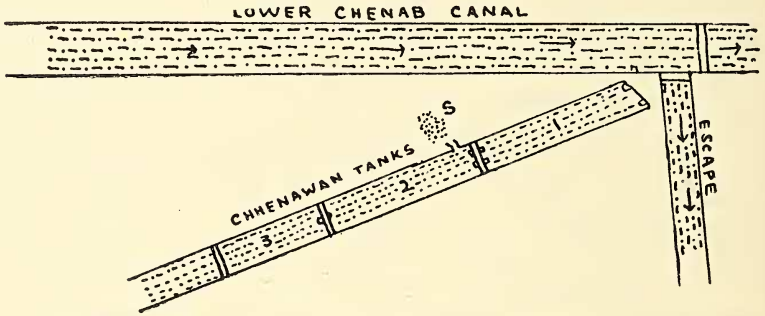

Fig. 4.—Diagrammatic sketch of Chhenawan Tanks, showing spawning grounds (*S*).

by Dunsford (1911, p. 13), was established in 1923. A portion of about two miles in length is utilized for this purpose and is divided into three parts by construction of earthen bunds. Adult Carp, such as *Labeo rohita*, *Labeo calbasu*, *Cirrhina mrigala* and *Catla catla* have been introduced into the second tank, which during the monsoon receives rain water through a storm channel and gets flooded. Its water overflows into the surrounding fields, where fish coming out of the tank, indulge in sexual play and lay their eggs.

During the last 18 years the Carp at *Chhenawan* have spawned four times only, *i.e.* once in 1923, then in 1928 and 1929 and again in 1933. The observations on their spawning recorded during these years are as under:—

1923.—It rained 2.65 inches on the 9th July and 1.55 inches on the 10th July. All the fields near the storm channel were under water and the fish were seen playing and spawning there. At 2 p.m.

the fish returned to the tank, as rain had stopped and water in the fields had gone low. The eggs, which were lying scattered, chiefly near the ridges of the fields, were collected. They hatched out on the 11th morning. The temperature of water was:

9-7-1923 Tank . . . morning 82°F., noon 84°F., evening 78°F. 10-7-1923 Spawning Fields: morning 76°F., noon 79°F., evening 78°F.

1928.—A heavy storm came on during the middle of the night of the 23rd July, and by the morning of the 24th the water from the fields was coming through the storm channel. About mid-day, the fish were noticed ascending the channel and there tremendous splashing took place and the fish were seen laying their eggs near the edges of the channel where water was shallow. A half spent up female of *Cirrhina mrigala*, netted from the spawning ground, yielded its eggs with a slight pressure on its abdomen. The eggs were fertilized with milt from a male and kept in hatching trays. They hatched out on the 25th morning, 17 hours after they were laid. The temperature of flood water on the 24th was 75°F. in the morning, 92°F. to 49°F. in the afternoon.

1929.—It rained 2.3 inches on the morning of the 17th July and at 2 p.m. the tanks, the channel and the spawning grounds were fully flooded, but no fish responded to the flood, till the morning of the 18th when they came out in shoals, played on the grassy banks of the channel and laid their eggs. One female *Cirrhina mrigala* was netted, when pairing, and it yielded its eggs readily, which were fertilized successfully. The temperature of water in the tank and the spawning grounds was as under:—

17-7-29 Tank, 9.30 a.m. 85°F., Spawning Fields 78°F.

18-7-29 Tank, 9 a.m. 82°F., Spawning Fields 80°F.

1933.—It rained 2.9 inches during the night between the 16th and 17th July, and the flood water began to flow into the tank at 8 a.m. The fish responded to the flood immediately afterwards and moved into the channel but did not lay their eggs. The eggs taken out of a female *Cirrhina mrigala*, netted from the channel, were found to be hard and opaque. It was at 5-30 p.m. that the first pair of *Cirrhina mrigala* was netted actually in the act of spawning. The female was half spent up and easily yielded its eggs, which were soft and translucent and were successfully fertilized when mixed with milt from a male. The spawning continued during the night as well, The temperature of the tank water before the flood on the 17th July was 78°F. and after the flood it was 80°F., while of the water where the fish actually spawned was 87°F.

During the remaining 14 years, the Carp at *Chhenawan* refused to spawn, because in most of the years the rain was either insufficient to flood the tank and the spawning grounds or not in time. Rainfall at *Chhenawan* during the month of July for the years 1923 to 1940 is given in the Table and the dates on which the fish spawned are marked with an asterisk. Insufficient floods in June did not stimulate the fish and the floods caused by rains in August and September had no effect on the fish at all. In most of the years during which the Carp did not spawn the rainfall during the month of July was discontinuous and thus did not cause sufficient flood to inundate the spawning grounds. In July 1930, for instance, the

total rainfall for the month of July was quite heavy, but to prevent a breach in a newly constructed bund the level of the tank had been kept very low, *i.e.* 3 feet, and the individual rains did not bring in sufficient water to fill the tank to its flood level, *i.e.* to 9 feet. The fish, however, refused to lay their eggs in the tank, though the flood water from the surrounding land, caused by the rains, had flowed into it, but was not sufficient to flood the tank and inundate the spawning grounds. In 1938, it rained 3.8 inches on the 24th July, the channel and the fields were flooded, but the rain had stopped abruptly, the sun had come out and the temperature of the shallow water in the fields rose from 76°F. to 96°F. in the evening. The fish, which had responded to the flood and had entered the spawning grounds, returned to the main tank without laying their eggs. It was probably their instinct that warned them of danger of high temperature that threatened their eggs and fry if they had spawned in shallow water in the fields. Again, in 1940, the rainfall on the 12th July was quite heavy, but before the tanks could be flooded the rain had stopped. Subsequent rains in July in that year, too, were insufficient to flood the tank and the spawning grounds and the fish did not spawn.

(ii) *Khori Ponds* (Fig. 5). The fish from *Niki Deg*, a tributary of River Ravi, have spawned almost annually during the monsoon near village *Khori*. There are two ponds near this village which dry up in May and June, but get inundated with floods in the *Niki Deg* in July and the fish, ascending with the floods, play on the grassy banks of the pond and the surrounding fields, which are all under water, lay their eggs and return to the main stream.

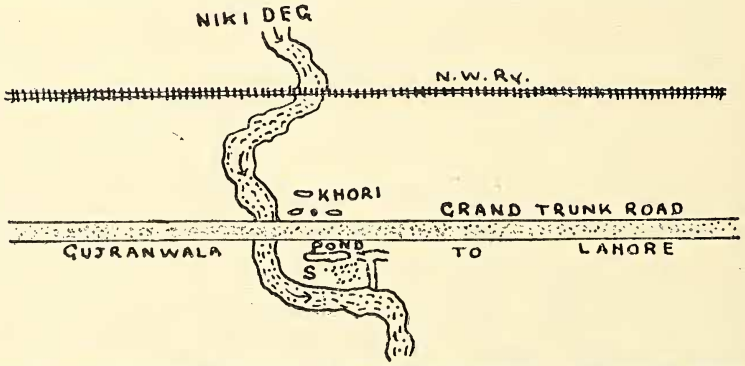

Fig. 5.—Diagrammatic sketch of spawning grounds (*S*), near village *Khori*.

When the floods subside, the pond is cut off from the main stream and numerous fry become stranded there. In 1940, more than 15,000 Carp fry, mostly of *Labeo rohita*, *Cirrhina mrigala* and *Catla catla*, were netted from this pond and transported to stock other waters.

C. Spawning of Carp in Tanks and Ponds which are always unconnected with any large piece of running water.

Observations on the spawning of Carp were carried out on such tanks at *Lyallpur* and *Chhenwan* as are always unconnected with

any large piece of running water. The Carp in these tanks grow splendidly, become ripe in May and June, their ovaries become distended with eggs, but they refuse to lay them and become egg bound. Attempts to strip them in July result in hard, opaque eggs, which come out with great pressure and are often mixed with blood, and do not fertilize when mixed with milt from the male.

In 1934, and again in 1941, an artificial flood was created in a pond at *Chhenawan,* containing a few pairs of ripe Carp, by means of a pump. The fish responded to the flood, moved into the flood channel, but did not indulge in sexual play and returned to the main pond after a few hours stay in the channel. Apparently the conditions, which could induce spawning, were not reached.

Study of the eggs from ripe female Carp, netted in July and August from confined waters, showed that the eggs were hard and opaque. A condition, similar to one obtained at the time of spawning at *Chhenawan* and other natural spawning grounds, when the female readily yielded soft and translucent eggs, could not be observed at any time of the year in the fish confined in such tanks and ponds as are always unconnected with any large piece of running water. As the breeding season advances the eggs in the ovaries become smaller and smaller in size and are ultimately reabsorbed by the fish. It has, however, been possible to affect ovulation by injecting ripe female Carp with Antiturin S, Prolan or the extract of Anterior Lobe of Pituitary Gland. The injected fish yield eggs readily, but fertilization of these eggs by mixing them with milt from the male has not so far been successful (Hamid Khan, 1938).

The Indian Carp, therefore, do not breed in such confined waters as are always unconnected with any large piece of running water. In semi-confined waters, as for instance tanks at *Chhenawan,* these fish do spawn, provided that the tanks and the spawning grounds are inundated by timely rains. Their spawning behaviour, thus, differs from that of the European Carp, which have no hesitation to breed in confined waters (Hall, 1929), their eggs 'being adhesive become attached to the roots and stems of grass and other aquatic vegetation or to whatever objects chance to cover the bottom where they are deposited', (Gupta, 1938, p. 98). The behaviour of European Carp in this respect is similar to that observed in the case of smaller varieties of the Asiatic Carp, such as Gold Fish (*Carassius auratus* L.), (Hamid Khan, 1939) or *Barbus* (*Puntius*) *sophore.*[1]

Such controlled or 'Test-Tube' cultivation, as is possible in the case of Trout (*Salmo fario* L.), (Hamid Khan, 1940) or in the Western Carp, is not at present practicable in the Indian Carp. One has to depend entirely on their natural spawning grounds for the supply of eggs and fry to stock other waters. At *Chhenawan,* for instance, whenever the Carp spawned, the eggs were collected, fry reared and transported to stock other waters. At *Khori,* too, the Carp fry have been utilized for the same purpose. A similar procedure is adopted in Bengal, where local fishermen collect the eggs

[1] *Barbus* (*Puntius*) *sophore,* one of the smaller varieties of the Carp, growing to 3 or 4 inches in length, has been observed to breed freely in confined waters, such as tanks and ponds, both at *Lyallpur* and *Chhenawan.*

from the natural spawning grounds, transfer them to hatching pits and rear the fry for sale for stocking tanks and ponds (Majumdar, 1940).

D. Probable factors which induce the Carp to Spawn.

The study of the breeding habits of the Carp, seems to indicate that the probable factors which induce these fish to spawn are the following:—

1. *Rains.* The fish become ripe in May and June, and wait for the monsoon rains. With the first shower of rain in June, the fish move up the main stream in search of suitable spawning grounds and wait for the floods. If there are no rains or if the rains do not cause any flood, the fish do not spawn.

2. *Floods.* Whether caused by local rains or rains in the hills, floods constitute a very important feature in the spawning of Carp. With floods in the river and its tributaries, the fish leave the main channel and ascend the inundated fields to lay their eggs in shallow waters, which are quite suitable for the puny strength of the tiny fry that come out of the eggs within less than 20 hours. It is, therefore, not surprising that the floods which are insufficient to inundate the spawning grounds, or are untimely, do not stimulate the fish to spawn. Instinctively the fish will not lay their eggs in the main channel, where water is too deep, as the eggs, which sink to the bottom, will not have much chance to hatch out.

3. *Temperature.*—Rains and floods may induce the fish to ascend to their spawning grounds, but they will not spawn if the temperature is too high. The fish have been observed to leave the spawning grounds when the temperature rose from 76°F. to 96°F. The temperature in the spawning grounds generally ranges from 75°F. to 87°F.

4. *Chemical and Physical Factors.*—Analysis of water from the spawning grounds and from the main stream during the breeding of the fish did not show much difference either chemically or physically. Moreover, if it were chemical and physical constituents of the flood, which were mainly responsible for the spawning, the fish at *Chhenawan* would have spawned every year as the flood from the surrounding fields, caused by the local rains, invariably entered the tank during the monsoon. But they did not do so. It was only when the flood inundated the tank, the channel and the spawning grounds that the fish felt the urge to move out, play together and then lay their eggs.

5. *Endocrine secretion.*—It has been observed that when the fish first enter the inundated fields, their eggs are hard and opaque, and it is only when they have played together for a period lasting from 5 to 12 hours that their distended bellies become limp, eggs leave the follicles, become translucent and flow out of the vent on slight pressure. It is on such occasions that a female can easily be stripped, provided that the fish is ready to shed its ova, otherwise any attempt to press the eggs out results in hard and opaque bodies, which are often mixed with blood. It is, therefore, reasonable to believe that though rain, flood, temperature and chemical and physical factors induce the fish to ascend to their spawning

grounds and stimulate them to indulge in sexual play, some internal secretion is responsible for the ovulation and for change in the eggs that makes them translucent. It has been possible to make the Carp, kept in captivity, yield its eggs readily on stripping, by the administration of extract of Anterior Lobe of Pituitary Gland. This behaviour of the Carp seems to indicate that it is probably the pituitary sex hormone which is directly responsible for ovulation. The discharge of such hormone may be a consequence of some meteorological phenomenon as rain, flood or other chemical or physical environmental factors, (Hamid Khan, 1938).

5. *Domestication.*—The Indian Carp, it may be argued, is not yet fully domesticated. Its domestication is a recent event, while that of the European Carp is a century old. It is true that the male readily yields its milt and it is only the female that feels shy to part with its eggs in confined waters. In the years to come it may, however, be possible to induce these fish to spawn under control in confined waters when they find it impossible to get an access to a river or to any other piece of running water.

E. Conclusion.

Our inland fisheries have undoubtedly deteriorated due, chiefly, to untimely slaughter of fish, specially during their breeding time and destruction of their eggs and fry. Improvement of our indigenous fisheries by introduction of 'Test-Tube' or controlled cultivation is not a feasible proposition at present, and one has to depend entirely on the natural spawning grounds for supply of eggs and fry to stock the depleted waters. It is, therefore, recommended that deterioration may be prevented by adoption of such suitable measures as, *firstly,* proper facilities for the fish to ascend to their spawning grounds, *secondly*, protection, by means of legislation, of fish, of their ova and of their fry during their breeding season from wholesale destruction; *thirdly*, establishment of nurseries near the spawning grounds to ensure the development of eggs and fry and to lessen the chances of their destruction; and *fourthly,* salvage of fry from pools, where they become stranded after floods have subsided, and stocking the depleted waters with them.

F. Summary.

1. Observations on spawning of Carp in the Punjab have been recorded *firstly*, from their natural spawning grounds on the Rivers Beas, Sutlej, Ravi and their tributaries; and *secondly*, from tanks at *Chhenawan*, *Khori* and *Lyallpur.*

2. The Carp in the rivers and their tributaries spawn in July when the streams are flooded by the monsoon rains and overflow into the surrounding fields. The fish lay their eggs in the inundated fields. The Carp, confined in tanks at *Chhanawan*, spawned when rainfall was heavy and the tanks, together with the spawning grounds, were flooded. During the years that the rainfall was either untimely or insufficient to flood the spawning grounds, the fish did not spawn and the eggs were reabsorbed by the fish. In the pond at *Khori*,

the fish from a tributary of the river Ravi obtained access to it during July, played on its grassy banks and inundated fields, laid their eggs and then returned to the main stream. In the tanks at *Lyallpur,* which are not connected with any large piece of running water, the Carp grow splendidly, become ripe in May and June, but refuse to lay their eggs.

3. Rain, flood, temperature and other environmental factors induce the fish to ascend to their spawning grounds and stimulate them to indulge in sexual play, but endocrinal secretion seems to be responsible for the actual ovulation.

4. The supply of Carp in our rivers and the replenishing of our depleted waters, at present, depends entirely on natural spawning of the Carp. To improve our inland fisheries it is, therefore, recommended that the fish may be protected from wholesale destruction during their breeding season and proper facilities afforded to them to ascend to their natural spawning grounds.

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Table

Showing Rainfall at Chhenawan in July for the years 1923 to 1940

Date	Rainfall in inches	Date	Rainfall in inches	Date	Rainfall in inches
1923		**1924**		**1925**	
9-7-1923	2·65	21-7-1924	0·25	9-7-1925	0·25
**10-7-1923*	*1·55*	27-7-1924	1·80	10-7-1925	1·80
12-7-1923	0·50	28-7-1924	0·55	17-7-1925	1·00
17-7-1923	0·37		——	21-7-1925	0·70
20-7-1923	0·80	Total ...	2·60	24-7-1925	0·45
23-7-1923	2·65			28-7-1925	0·10
	——			31-7-1925	1·10
Total ...	8·52				——
				Total ...	5·40

* The dates on which the fish spawned.

TABLE I—(*contd.*)

Showing Rainfall at Chhenawan in July for the years 1923 to 1940—(*contd.*)

Date	Rainfall in inches	Date	Rainfall in inches	Date	Rainfall in inches
1926		**1931**		**1936**	
10-7-1926	0·14	2-7-1931	0·65	4-7-1936	1·10
11-7-1926	0·80	5-7-1931	1·95	6-7-1936	0·60
26-7-1926	1·15	11-7-1931	1·80	7-7-1936	1·40
31-7-1926	0·50	13-7-1931	0·20	17-7-1936	0·50
Total ...	2·59	21-7-1931	0·70	28-7-1936	0·90
1927		23-7-1931	0·60	29-7-1936	0·30
6-7-1927	0·23	24-7-1931	0·30	Total ...	4·80
7-7-1927	0·85	30-7-1931	1·60	**1937**	
9-7-1927	0·55	Total ...	7·80	15-7-1937	1·35
16-7-1927	0·45	**1932**		16-7-1937	0·70
22-7-1927	0·05	12-7-1932	3·00	21-7-1937	0·54
26-7-1927	0·40	15-7-1932	0·50	22-7-1937	0·35
27-7-1927	0·30	20-7-1932	0·15	27-7-1937	0·25
Total ...	2·83	24-7-1932	1·50	28-7-1937	0·15
1928		28-7-1932	0·13	29-7-1937	0·05
1-7-1928	0·67	30-7-1932	1·00	Total ...	3·39
21-7-1928	0·60	Total ...	6·28	**1938**	
22-7-1928	0·65	**1933**		24-7-1938	3·8
*24-7-1928	*1·55*	4-7-1933	0·30	Total ...	3·8
25-7-1928	0·40	10-7-1933	0·30	**1939**	
Total ...	3·87	15-7-1933	1·10	2-7-1939	0·10
1929		16-7-1933	0·65	8-7-1939	0·35
3-7-1929	1·00	*17-7-1933	*2.90*	9-7-1939	0·27
6-7-1929	0·30	19-7-1933	1·10	Total ...	0·72
17-7-1929	2·30	23-7-1933	0·10	**1940**	
*18-7-1929	*0·95*	27-7-1933	0·50	2-7-1940	0·50
19-7-1929	0·90	30-7-1933	0·90	5-7-1940	1·20
24-7-1929	0·20	31-7-1933	2·10	12-7-1940	2·20
25-7-1929	0·90	Total ...	9·95	18-7-1940	1·75
28-7-1929	0·25	**1934**		21-7-1940	0·20
Total ...	6·80	4-7-1934	0·40	22-7-1940	0·90
1930		7-7-1934	1·70	23-7-1940	0·20
4-7-1930	1·55	8-7-1934	1·30	29-7-1940	1·00
5-7-1930	0·55	28-7-1934	0·60	30-7-1940	0·10
9-7-1930	0·50	29-7-1934	0·40	Total ...	8·05
11-7-1930	1·10	30-7-1934	0·30		
13-7-1930	1·00	31-7-1934	1·70		
14-7-1930	0·75	Total ...	6·40		
24-7-1930	1·95	**1935**			
25-7-1930	0·30	16-7-1935	0·80		
27-7-1930	1·00	18-7-1935	1·20		
29-7-1930	0·45	24-7-1935	0·90		
30-7-1930	0·90	25-7-1935	0·16		
Total ...	10·05	Total ...	3·06		

* The dates on which the fish spawned.